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UNITED STATES DISTRICT COURT

NORTHERN DISTRICT OF CALIFORNIA

SAN FRANCISCO DIVISION

WAYMO LLC, Plaintiff, v. UBER TECHNOLOGIES, INC., OTTOMOTTO LLC; OTTO TRUCKING LLC, Defendants.	Case No. 3:17-cv-00939-WHA **DECLARATION OF SCOTT BOEHMKE IN SUPPORT OF DEFENDANTS' OPPOSITION TO PLAINTIFF WAYMO LLC'S MOTION FOR PRELIMINARY INJUNCTION** Date: May 3, 2017 Time: 7:30 a.m. Ctrm: 8, 19th Floor Judge: The Honorable William Alsup Trial Date: October 2, 2017

REDACTED VERSION OF DOCUMENT SUBMITTED UNDER SEAL

I, Scott Boehmke, declare as follows:

1. I am an engineering manager within the Advanced Technologies Group at Uber Technologies, Inc. ("Uber"), where I am responsible for hardware development and application in Uber's self-driving vehicle project. I understand that Waymo has filed a lawsuit against Uber, Ottomotto LLC ("Otto") and Otto Trucking LLC in the U.S. District Court for the Northern District of California. I submit this declaration in support of Defendants' Opposition to Waymo LLC's ("Waymo") Motion for Preliminary Injunction. I have personal knowledge of the facts set forth in this declaration and, if called to testify as a witness, could and would do so competently.

2. I have never worked for Google or Waymo. I joined Uber in February 2015 as a senior engineer in Uber's newly created Advanced Technologies Center ("ATC") in Pittsburgh, Pennsylvania, to research and develop autonomous vehicle technologies. After Uber acquired Otto in August 2016, I, along with the rest of the ATC team, became a member of Uber's newly formed Advanced Technologies Group. Since joining Uber in February 2015, I have been responsible for hardware development and application in Uber's self-driving vehicle project. Prior to joining Uber, I worked for eight years as a project engineer at Carnegie Mellon University (CMU), where I specialized in robotics. I worked on control, power, and communications electronics, as well as design and configuration of light detecting and ranging (LiDAR) and RADAR sensors during my tenure at CMU.

3. I have never knowingly taken or received any confidential Google or Waymo documents or information for use at Uber. I have never knowingly used any confidential Google or Waymo documents or information in my work for Uber. I was never directed by anyone at Uber to use any confidential Google or Waymo documents or information for the design or development of Uber's LiDAR and self-driving vehicle technology. I have never seen any evidence of any confidential Google or Waymo files being used during my work at Uber.

Development of LiDAR Technologies at Uber Prior to the Otto Acquisition

4. I became involved in Uber's application of LiDAR technology in early March 2015. During that time, I traveled to California to meet with three leading companies in the LiDAR space—Velodyne Acoustics ("Velodyne"), Quanergy Systems ("Quanergy"), and Tyto

LIDAR LLC ("Tyto")—to evaluate what third-party options were available to Uber for LiDAR sensors. Shortly after this trip, I prepared a presentation dated April 17, 2015, entitled "AV Sensor Thoughts," for the ATC team at Uber. This presentation includes my analysis of the field of view and beam spacing requirements needed for self-driving vehicles. Attached hereto as Exhibit A is a true and correct copy of excerpts of AV Sensor Thoughts.[1]

5. Throughout 2015, I continued to meet with other companies in the LiDAR and 3-D sensing space, including [redacted], to evaluate the option of having an outside company produce a LiDAR sensor for Uber's application. During that time, I was also working on developing requirements for a new LiDAR sensor. Attached hereto as Exhibits B and C are true and correct copies of excerpts of my LADAR Design Notebook from October and December 2015, respectively. The LADAR Design Notebook includes my evaluations of third-party LiDAR sensors, as well as my own work in developing LiDAR requirements for Uber's intended applications.

6. The October 15, 2015 version of my LADAR Design Notebook, Exhibit B, shows my efforts to structure the requirements for a new LiDAR sensor configuration according to various system performance and operating environments, such as how far a car would travel between sensor detection and the reaction time of the vehicle ("reaction distance") for a car traveling at different speeds (e.g., 25 mph, 35 mph, etc.) and what beam angles would be necessary to detect objects of a certain size (e.g., 0.15 to 0.5 meter) at certain distances (e.g., at a range of 10 to 200 meters). Through this analysis, I recognized that the vertical field of view and resolution requirements are heavily dependent on the speed of the vehicle, and we considered adjusting the angular beam spacing (e.g., of laser diodes) in the vertical dimension based on the speed of the vehicle. *See* Exhibit B at pages 2-8. In fact, I had filed a provisional application on December 15, 2015 for [redacted]. I also filed a non-provisional

[1] Excerpts are provided to avoid disclosing third-party confidential information.

application claiming priority to this provisional application. Attached hereto as Exhibits J-P are true and correct copies of my provisional application documents (Exhibits M-P) and non-provisional application documents (Exhibits J-L).

7. During that time, I was also considering a potential in-house LiDAR solution using a 1550nm fiber laser, with "[p]olygonal mirrors for fast horizontal scan" and [redacted]. *See* Exhibit B at page 26.

8. The October 15, 2015 version of my LADAR Design Notebook also includes my analysis of LiDAR sensors that Velodyne and Quanergy could potentially provide to Uber. *See* Exhibit B at pages 9-11, 13-16, 19. For example, page 10, reproduced below, shows the laser distribution of the diodes in the [redacted]

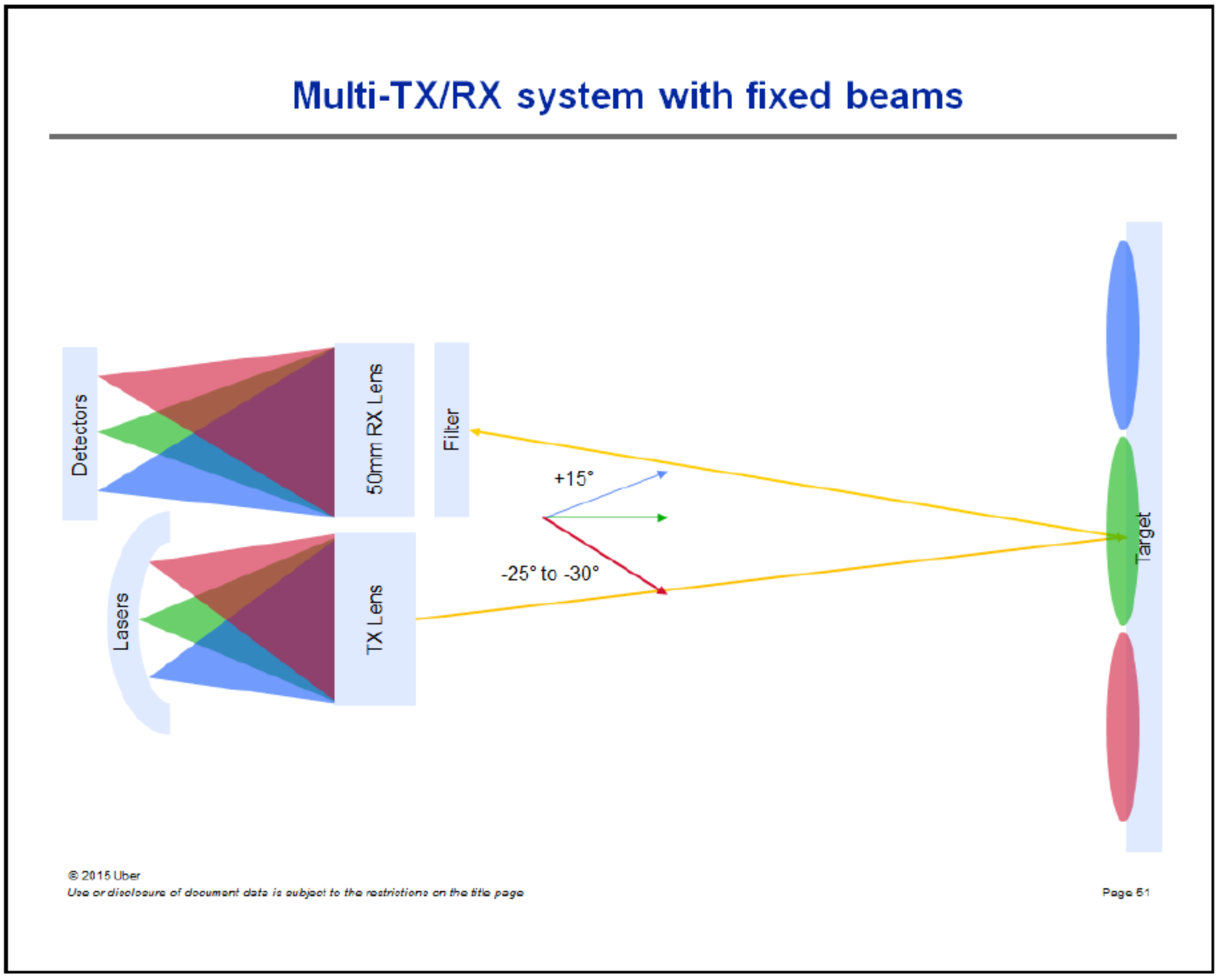
[redacted]

9. In March 2016, Uber entered into a contract with [redacted] under which [redacted] agreed to develop for Uber [redacted] based on custom beam patterns and parameters that we provided to [redacted] Uber would assemble [redacted] into its custom designed mount, which stacked them to provide [redacted] (hereinafter referred to as the "dual stack"). From November 2015 through March 2016, I worked on developing the custom beam patterns and parameters necessary for Uber's automotive use, taking into account the technical constraints of [redacted] Attached hereto as Exhibit D is a true and correct copy of a request for quotation (RFQ) that Uber provided to [redacted] on December 7, 2015 for a LiDAR sensor capable of providing Uber's requested field of view requirements. Attached hereto as Exhibit E is a true and correct copy of excerpts of the preliminary specifications that Uber provided to [redacted] on December 15, 2015. Attached hereto as Exhibit F is a true and correct copy of the final specifications Uber provided to [redacted] according to Uber's custom beam pattern and parameters.

10. In creating these documents (Exhibits D, E, and F), I calculated the custom beam patterns and parameters based on the requirements of the car (e.g., the beams must pass over the hood of the car), the standard specifications of public roads (e.g., the maximum grades for public roads), and the resolution needed for obstacle detection while self-driving at various speeds. These custom beam patterns create [redacted]. As the beams of light travel farther distances, the angular difference between the beams of light translate into increased vertical gaps. [redacted]

11. The contract between Uber and [redacted]. As of March 2017, [redacted].

12. By late 2015, I was considering [redacted] to permit the use of a simple transmit lens. I was also considering the use of separate transmit and receive lenses for the optical transmit and receive paths, which I had understood to be the state-of-the-art at the time. This was memorialized in the December 7, 2015 version of my LADAR Design Notebook (Exhibit C), which has a last modified date of January 2016. Slide 51, reproduced below, illustrates this:



13. Attached hereto as Exhibit G is a true and correct copy of my analysis of using multiple lasers on each transmit board, entitled "2016-02-17-OurVersion," which was last modified on February 17, 2016. At the time, I was exploring how to position and orient the lasers behind one transmit lens on as few boards as possible to simplify alignment and calibration. I envisioned [redacted] to enable the use of a simple lens design.

Interactions with Otto

14. In May 2016, Uber was considering several different LiDAR options. Attached hereto as Exhibit H is a true and correct copy of "LIDAR Thoughts," which summarizes three options Uber was considering for LiDAR sensors, as of May 2016. Plan A was to use [redacted] with Uber's custom beam pattern and parameters to form the previously described dual stack. [redacted] *See* Exhibit H at pages 5-7. Plan B was to use a potential in-house diode-based LiDAR sensor that would be simpler to fabricate and would have improved specifications over [redacted]. Slide 10 discloses improvements on [redacted]. *See* Exhibit H at pages 8-12. These improvements incorporate concepts from my earlier work in late 2015 discussed above. Plan C was to use a fiber laser design based on Uber's discussions with Otto in late April and May 2016, which included discussions about the possibility of using eight fiber lasers to scan wide areas. *See* Exhibit H at pages 13-17. For example, slides 14 and 15 show an early proposal of using eight fiber lasers that were potentially split in four, six, or eight, to allow for 32, 48, and 64 beams respectively. These three options were not exhaustive, and Uber was considering other options as well.

15. Before Uber acquired Otto in August 2016, I was working with [redacted]

[redacted] we remain constrained as to how much data we have collected using these LiDAR sensors.

Involvement in the Fuji Design

16. In October 2016, Eric Meyhofer and I met with James Haslim and concluded that the fiber laser LiDAR design that James and his team were working on (i.e., Plan C) was undesirable for use in Uber's vehicles because of the complexity of that design, as well as its heavy weight and bulky size. We decided that James and his team should pivot and instead focus on developing what we dubbed the "Fuji" design, an in-house diode-based LiDAR sensor based on the design that I was previously considering in late 2015, well before the acquisition of Otto. The Fuji design was intended as an alternative to [redacted]. By October 2016, [redacted]. Because we would not be able to further our self-driving project without additional LiDAR sensors, [redacted], we proceeded with alternatives, including the aforementioned Fuji design.

17. In early November 2016, I visited James Haslim and his team in Uber's San Francisco office to review the work that they had undertaken since pivoting to the Fuji Design. This work included [redacted] for the Fuji design. It was during that review that I suggested to James's team to use an inductor-less design for the laser diode driving circuit because it is simpler than an inductor-based design and avoids undesirable electrical noise into the system.

18. The position and orientation of the diodes on the transmit boards in Fuji is based on custom beam spacing and angles I developed using parameters and calculations [redacted]. Exhibit I is a true and correct copy of the custom beam spacing and angles summary I developed and provided to James Haslim's team on November 4, 2016. This summary calculates the beam spacing and angles for

given obstacle parameters. The summary provided beam spacing and angles for a 64 channel LiDAR on a vehicle optimized for traveling at 30 mph, 35 mph, 40 mph, and 45 mph. I understand that James and his team used the data in this summary to generate the initial optical cavity designs and transmit PCB designs for the Fuji design.

I declare under penalty of perjury under the laws of the United States that the foregoing is true and correct. Executed this 7th day of April, 2017, in Pittsburgh, Pennsylvania.

Scott Boehmke